404.710 P

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 178 870**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **85307314.6**

(22) Date of filing: **11.10.85**

(51) Int. Cl.⁴: **B 08 B 9/02**
F 16 L 58/02, E 21 B 47/00
E 21 B 37/00, E 21 B 41/02

(30) Priority: **12.10.84 GB 8425870**

(43) Date of publication of application:
23.04.86 Bulletin 86/17

(84) Designated Contracting States:
BE DE FR GB IT NL

(71) Applicant: **Cruickshank, John Smith**
39 Meadowview Drive Craigdarroch Park
Inchture Perthshire Scotland(GB)

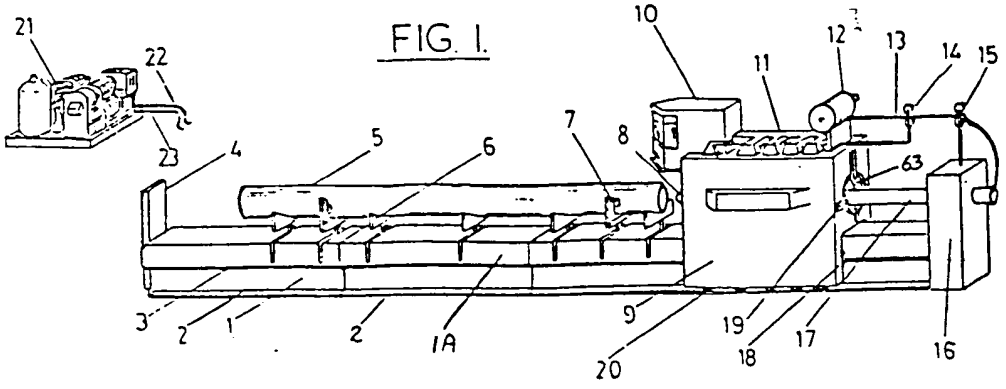
(72) Inventor: **Cruickshank, John Smith**
39 Meadowview Drive Craigdarroch Park
Inchture Perthshire Scotland(GB)

(74) Representative: **Bowman, Paul Alan et al,**
LLOYD WISE, TREGEAR & CO. Norman House 105-109
Strand
London WC2R OAE(GB)

(54) Method and apparatus for the servicing and inspection of pipes.

(57) A method and apparatus for treating very large pipe sections such as those used for oil or gas wells, in which one or both cyclindrical surfaces of the pipe sections are processed entirely throughout the length and circumference of the pipe, in one cycle of operation. The processing comprises cleaning and one or more of the following treatments: inspection, coating with a corrosion preventative material and forced-air drying and the inspection process will include remote optical/video scanning of the whole circumference of the pipe. The preferred apparatus comprises a bed (1a) on which the pipe section is supported, an external processing unit (9) and a probe (8), both of which are advanced down the pipe section and retracted with a fixed spatial relationship and both of which contain means for treating the respective pipe surfaces. In a second embodiment the probe is used on its own as a means for cleaning and inspecting down-hole pipe conditions around 360° of the circumference of the pipes.

FIG. 1.



EP 0 178 870 A2

"METHOD AND APPARATUS FOR THE SERVICING AND INSPECTION OF PIPES"

BACKGROUND OF INVENTION

This invention relates to the cleaning, inspection, and protective coating of tubular members (pipes and tubes), prior to their installation, and for the inspection of such members for faults, corrosion or other damage while forming part of an installation.

DESCRIPTION OF PRIOR ART

Tubular members which in use are subjected to strain, pressure, tension, temperature, or corrosive attack, are required to meet set standards and it is highly desirable that defects such as corrosive attack on the wall surfaces, wall thinning during drawing, ovality, and internal wall faults such as cavitation, reeding, or scale inclusion, are sought for and found, if existing, prior to installation, particularly where the installation is to be below the surface of the Earth or in an environment hostile to man. However, difficulties have been encountered in the oil production industry with the unexpected failure of process piping (e.g. that used "down-hole" or for conveying the extracted oil to storage or processing means) even in circumstances where the tubular members have been previously unused and where on manufacture they were checked out as conforming to manufacturing specifications. On investigation it has been found that a principal cause of the problem is the incidence of corrosion under the protective coating of the tubular members during pre-use storage.

After further investigation it is now found that this problem

has arisen, as a consequence of the physical size of the tubular members, because the normal pre-installation cleaning processes and the process of applying corrosion inhibitors have not taken place simultaneously or not at the same location. Also, with such tubing it is unknown in the field to treat the internal and external surfaces simultaneously. One of the consequences of treating these surfaces at different times is that an already treated surface becomes contaminated or damaged during the treatment of the other surface. The present invention is directed to overcoming these problems. Thus the industrial activity most likely to gain advantage by use of the invention is considered to be the oil and gas production and supply industry, though any industrial activity involving the use of long tubular members or hollow sections many yards (metres) long can benefit.

While various methods presently exist to carry out individual functions, or dual functions unrelated to the functions of the present invention in one operation, no equipment presently exists which can carry out the multiplicity of functions necessary to ensure the comprehensive cleaning, inspection checks, and the application of protective coatings to tubular members, in the manner, method or speed, with which the invention can accomplish this work, all prior to the tubular members being installed, and/or to carry out internal wall three dimensional inspection of the tubular members after installation.

OBJECTS AND SUMMARY OF THE INVENTION

It is a primary object of the present invention to provide a

method and means for treating large pipe sections, such as those used in oil or gas extraction, transportation, processing and distribution such that at least one, entire, surface thereof is cleaned and examined and, or treated for the prevention of corrosion in a single continuous operation. Such an operation will involve both a forward and reverse passage of said means along the entire said surface. Another object of this invention is to provide means for the treating of both the inside and the outside wall surfaces of said pipe sections simultaneously.

Yet another object of this invention is to provide means for remote down-hole treatment of already installed pipes, said treatment including the cleansing and inspection and, or treating for the further prevention of corrosion of the interior of the pipe sections.

Accordingly in one of its aspects the invention provides a process for continuously treating tubular members by progressive zonal treatment along the length of the member, such treatment including cleaning or applying a protective coating or inspecting the same surface, or any combination of these operations in the same cycle of operation on the member, the latter operation comprising both a forward and a return pass along the member. In the preferred process both external and internal opposed surfaces are dealt with simultaneously.

The invention furthermore provides apparatus for treating tubular members by progressive zonal treatment along the length of the member in one cycle of operation in the above said manner,

comprising a bed for supporting the member along its length and means including cleaning, inspection and protective coating equipment which is arranged so as to pass along the length of the member and back again whilst continuously treating the latter over 360 degrees of its surface. In the preferred arrangement said means includes means both internally and externally of the tubular member, such that both internal and external surfaces in the same zone are dealt with simultaneously and in synchronism.

In yet another aspect of the invention apparatus is provided for treating the internal surface of an installed pipe whereby the pipe is cleaned and inspected or provided with a protective coating therein, or any combination of these processes, said processes occurring in one cycle of operation on the pipe, or section of the pipe.

It is to be understood that in all said aspects of the invention the process of inspection may include testing for faults and the inspection means may include means for testing for ovality, for comformity to specified dimensions, for internal faults in the walls, for example cracking, reeding, cavitation or scale inclusion, and for inspection for corrosion or damage. Such means may comprise remote optical/video scanning and ultrasonic or atomic radiation emission scanning equipments.

In the preferred embodiment of apparatus according to the invention there is provided a means whereby the tubular members can be cleaned externally and internally by means of high pressure blasting using shot, sand and/or vapour; means whereby the internal and external wall surfaces are checked by non-contact----------

means for surface defects or damage, an ovality condition, or variations in wall thickness; means whereby the walls are checked by the ultrasonic scanning method for inclusions, reeding, or cavitation; and means whereby a coating of inhibitor liquid can be applied to internal and external wall surfaces without interferences, then subsequently force dried on the external surfaces to resist removal of the inhibitor during handling. In addition, an adaptation of equipment forming part of the apparatus provides a means whereby non-contact three dimensional inspections of the inner walls of tubular members can be carried out in installations where access to the members is only possible down the inside of the piping as in an oil or gas well for example.

Hereinafter the invention is further described by way of example with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates the general assembly of the apparatus to carry out a full service and inspection of varied sizes of tubular members, and about to carry out the operations on a large diameter case section for a production well.

Figures 2 and 2A illustrate the method of raising retracting and operating the tubular member supports and retaining clamps to enable a wide variety of tubular members of different diameters to be supported or gripped.

Figure 3 illustrates the hydraulic circuitry and depressable valve system required to retract the clamps and supports immediately prior to the advance of the processing unit, and to allow them to return to position once the processing unit has passed.

Figure 4 illustrates a plan view of the valve operating cam which is attached to the processing unit and controls automatically the raising and lowering procedure of supports and clamps.

Figure 5 illustrates a multi-operation probe which is located in the tubular member in a central position by triple or quadruple roller centralising units. This probe is fed with the various means required for its functions and is controlled in operation by means of an umbilical supply cable. The probe can be used down-hole.

Figure 6 illustrates an expanding and retracting sliding tube assembly which is attached to the probe and controls the advance and retraction of the probe in the tubular member being serviced in synchronisation with the movement of the processing unit.

Figure 7 illustrates a cut-away section of a processing unit for processing the external surface of the tubular members, and which traverses over and around the tubular members to be serviced and inspected.

Figure 8 illustrates the relative positions of probe and the processing unit during operation; this relativity is maintained through advance and retraction along the tubular members.

Figure 9 illustrates the operating circuits for the various operations carried out by both probe and processing unit of Figures 1 to 7.

Figure 10 illustrates the operator display unit for displaying the remote scanned profiles of the tubular member.

Figure 11 illustrates the use of the probe alone in the vertical position for the remote treatment and inspection of the pipe walls in a well or to carry out an examination of protective case section condition.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to Figure 1, there is shown a base assembly 1 comprising a bed 1A having a rail track 2 on either side running longitudinally at the base of the assembly. A continuous geared rack 3 runs parallel at either side along a line approximately half-way up the base assembly 1. A stop assembly 4 is mounted vertically at a first end of the base assembly 1. This is demountable and, as the base assembly is in sections for portability, can be mounted to the end of other base assembly sections. A tubular case section 5 which could be approximately 42 feet (12.6 metres) long and 36 inches (0.91 metres) in diameter is illustrated positioned on the bed 1A supported by adjustable and retractable vee supports 6 and held by adjustable and retractable clamps 7 both of which are retractable into slots in the bed 1A. A probe unit 8 is illustrated about to enter the case section 5 and is advancing along in synchronisation with the movement of an external processing unit 9 for processing the external surface of the case section, the operator having an overall view from the control cabin 10. On the roof of the processing unit is

a ducting 11, for dust extraction, and a dispensing and a gathering spool 12 for a probe umbilical cable 13 for providing control to the probe and for transmitting the results of scanning operations to the described hereinafter to the control cabin 10. A telescopic support 14 supports the umbilical cable between the spool and the fixed support 15 mounted on an expander housing 16 situated at a second end of the base assembly 1. A probe expanding and retracting sliding tube assembly 17 is attached to the probe 8. The umbilical cable 13 is carried through the tube assembly 17 to the probe.

Drive gears 18 mesh with the geared rack 3 and move the external processing unit 9 which is supported by free running wheels 20 running on the track 2. Triple or quadruple adjustable roller bearing centralisers 19 fitted to the front and rear of a processing tunnel in the processing unit 9 ensure that the case section 5 is held in a central position within the processing tunnel 63. A power skid 21 contains diesel generators, compressors, fuel tanks, controls, etc., to supply the main assembly with electrical power, via cables 22, and high pressure compressed air by way of armoured tubes 23. The skid enables the apparatus to be set up and operated in remote situations. A set of different diameter probes can be provided, which can be substituted one for another, to enable tubular members having a wide range of diameters to be processed.

Referring now to Figures 2, 2A and 3, there is illustrated a cross section through the base assembly 1 which is shown as having a bed 1A comprising a welded hollow section of heavy gauge and size with a base plate 2A along which run the guide rails 2, and

and welded drive racks 3. A vee support 6, which is one of a plurality, is made to rise and fall by a respective lifting means comprising hydraulic unit 24. Hydraulic pressure applied to either end of the hydraulic unit provides the means to move the vee support up or down. In its bottom-most position support 6 is retracted into a slot in the bed. A control valve for each support is mounted within the bed 1A such that its actuator protrudes through the side members of the bed. The latter is also provided with a plurality of clamps 7 for clamping the tubular member on the bed which are similar in their general structure to the support 6 and which are illustrated insofar as they differ therefrom in Figure 2A. As shown in the latter Figure, each also comprises, in addition to the lifting unit shown specifically in Figure 2, a double-acting hydraulic unit 26 controlling the jaws of the clamp so that they grip the sides of the tube 5. This hydraulic unit is also used to collapse the jaws prior to the retraction of the clamp 7 into its respective slot in bed 1A.

Referring now to Figure 3, this illustrates the circuitry between the valve 25 and the hydraulic unit 24. Control of hydraulic ram unit 24 is obtained by movement of an actuator spindle in valve 25 and by the supply of fluid pressure to the valve. With the valve as shown being kept extended by a spring, pressure is admitted to the base of the piston which is urged upwards in the cylinder. Depression of the valve pressurises the upper half of the cylinder and allows the lower half to exhaust,

causing a downward pressure on the piston so as to retract the support. A similar arrangement is used to control the hydraulic unit 26 of clamp 7. Position control of both arrangements is provided by means of a position sensor 65 which feeds back signals to a controller in control cabin 10, which in turn controls a master setting valve 64 (see Figure 9).

Referring now to Figure 4, this illustrates, by means of a plan view, a valve operating cam 25A which is attached to the external processing unit 9 and is arranged to depress the valves 25 of each support or clamp, in turn, as the processing unit moves along over the base assembly sections 1.

Referring now to Figure 5, this illustrates by means of a cross section the probe 8. Starting at the leading end on the left, or nose cone, the first section thereof carries shot, sand and/or vapour blasting nozzles 27 set in circular pattern facing forward. These are fed from an extension 13A of the umbilical cable 13, carried through the probe. The next nose cone section carries inhibitor liquid dispensing spray nozzles 28. These are also set in circular pattern facing forward and are fed from pressurised tank 32 which may be refilled from the umbilical cable 13. The next nose cone section has a circular array of air jetting holes or openings 29 supplied with compressed air provided by the umbilical cable. The nose cone capability as illustrated is shot, sand and/or vapour blasting to remove scale, rust, etc., air blast cleaning by means of the air jets and corrosion inhibition by means of an inhibitor which coats the interior surface of the

tubular member. The sections may be selectively operated or operated in different sequences.

Front adjustable roller centralisers 30 of probe 8 may be of the triple or quadruple arm type, and may be of the manual or hydraulic pressurised type. They maintain the probe in a central position in the tubular member. A filler plug 31 allows the manual filling of inhibitor liquid tanks 32. A bulkhead 33 separates the nose cone and inhibitor tanks from following inspection units provided in the probe. An armoured glass or acrylic 360-degree port section 35 in the probe body allows integral reflective surface 34 to provide a radial sheet of light generated by line scan laser 41 via prisms 40 and 50 and telescopic mounts 38. Line scan information of the pipe wall is provided by the video cameras 39 via a further reflective surface 36. Focus of each camera is remote controlled when required, by auto-focus units 37.

A method by the present inventor of mensuration in three dimensions using line scanning is the subject of a European Patent Application 84300028.2 which was published by the European Patent Office on the 18th July 1984 under publication No. 0113691 A and also the subject of a corresponding U.S. patent application 568381 filed on the 5th January 1984, and a similar method may be used in the present apparatus, the specifications of said prior applications being incorporated herein by reference. Controllers and signal boosting equipment therefor are housed in a distribution box 49.

A group of ultrasonic signal generators are located in circular

fashion in a double bulkheaded section 42; the bulkheads are lined with sound insulation and the signals are radiated outwards from the probe. The last section of the probe 44 provides space for additional equipment, for example: power pack, video recorder, signal amplifiers, mixers, modulator and transmitter, etc. Mounted on the outer diameter of this section of the probe case are retractable rear centraliser units 43 which may be similar to the front centralisers 30. A removable end cap 45 and a locking connector 46 connect the probe to a sliding tube assembly 17. The umbilical cable 13 has an armoured sheath 47 and is grommeted to a probe core skeleton tube 48.

Referring now to Figure 6, there is illustrated the probe 8 attached to the telescopic sliding tube assembly 17 which is in turn mounted in the expander housing 16. Reversible rubber drive rollers 51 in the expander housing 16 act on the armoured sheath 47 of the umbilical cable13 and are capable of speed adjustment, being synchronised with the drive motor/gearboxes for the processing unit. These drive rollers 51 as illustrated are one of the means for controlling the advance and retraction of the telescopic tube assembly. Air pressure bleed into the tubes causes the tubes to extend, and the drive rollers are used to control the speed of extension by drag on the armoured umbilical cable sheath. On the retraction stroke the air bleed is stopped and the drive rollers operate in reverse to pull the probe and sliding sections back.

Referring now to Figure 7, this illustrates the external processing unit 9 positioned part of the way along the base assembly

over a portion of the tubular member 5. Elements 1 to 20 have already been described with reference to the preceding figures. The probe 8 which would normally be simultaneously passing through the tubular member 5 is excluded from the figure to aid clarity.

The processing unit has in effect six separated chambers surrounding a processing tunnel 63. The first, 52, is hereafter referred to as The Inhibitor Drying Chamber and contains hot air ducts arranged in circular fashion to play pressurised hot air over the 360 degrees of the tubular member external surface. The next chamber, 54, hereafter known as The Inhibitor Application Chamber, contains spray jets arranged in circular pattern enabling pressurised inhibitor liquid to be sprayed on the circumference of a tubular member so as to provide a coating thereon. Inhibitor holding tanks are located above the spray jet ring.

On the bulkhead between this chamber and the next is a perforated diaphragm comprising an iris-type shutter with flexible tips which can be adjusted from the control cabin to partially seal around the tubular member. The next chamber 55, hereafter known as the Blast Chamber, contains blasting nozzles in a circular pattern facing forward at an angle in a double row. Through these nozzles can be passed shot, sand and/or vapour under pressure to clean the tubular member outer diameter. The chamber is lined with rubber/fabric bonded sheeting to prevent damage to the chamber walls, a grid section floor allows the shot or sand to be continuously recycled and fed back to the nozzles. The next chamber 56 hereafter known as the Air Cleaning Chamber contains air jet nozzles in a circular pattern.

These blow off any shot, sand, scale or dust left by the preceding blasting. Iris-type circular shutters are fitted at the entry and exit to this chamber. The next chamber, 57, is known as the External Surface Scanning Chamber. The latter chamber contains laser projection and video units 58 including cameras 59 which are adjusted by remotely controlled mechanisms, the cameras being mounted on radial sliders that allow them to advance or retract to suit the size of the tubular member 5. These units provide a full scanning of the outer circumference of the tubular member using a process similar to that used by the probe and disclosed in the Applications previously mentioned. The next chamber 60 hereafter known as the Sonic Chamber contains ultrasonic receptors 61 placed in circular pattern, these pick up the sound patterns from the ultrasonic senders in the probe 8, after the sound has passed through the walls of the tubular member; variations from norm in the signal patterns denote wall defects. This chamber is heavily sound insulated to ensure the receptors only pick up signals from the probe senders. Insulation 62 is provided all round the inner walls of the chamber. All sections or chambers are subjected to high vacuum dust extraction and particularly the chambers 53, 55 and 56, by means of the overhead ducting 11 which is linked with high vacuum extractor fans.

Referring now to Figure 8, this illustrates the position of the probe 8 in the tubular member 5 during the processing of the latter, and the tied relationship between section 35 of the probe and chamber 57 of the processing unit and section 42 of the probe

and receptors 61 of the processing unit. The sections of the probe and processing unit for internal wall scanning and external wall scanning require alignment to check for ovality and wall thinning. Similarly the ultrasonic units in the probe and processing unit are in alignment. This is why synchronisation of probe and processing unit traverse is required.

The method of use and the operation of the equipment is described hereinafter with reference to the preceding figures.

The diameter of tubular members to be serviced is ascertained, the appropriately sized probe is fitted (if not fitted already), and the power skid equipment is switched on to provide the electrical and pneumatic power supplies to the control cabin 10, the external processing unit 9 and the probe 8. The external processing unit and probe are retracted, the hydraulics for the supports 6 and clamps 7 are switched on, the support and clamp heights are set remotely from the control cabin to suit the tubular member, the clamp grips are likewise set to suit tubular member diameter. The centralising roller units 19, the iris shutters, the laser/video units 58 and sonic receptors 61 are set. The drive speed for movement set and synchronisation between probe 8 and operating unit 9 are checked. Shot/sand/vapour supplies and inhibitor supplies are checked on both probe and external processing unit, the probe centraliser units set, all other equipment checked for operation and setting to suit tubular member diameter. The first tubular member of a given size is lifted by yard crane or forklift and placed in the raised pipe supports, the clamps 7 are operated. Probe and processing unit scanning alignment is checked and both

are set in motion to perform a forward traverse along the tubular member. The shot/sand/vapour blasting sections 55 and 56, and 27 and 29, are now activated, as are sections/devices 57 and 60, and 35 to 42, and also dust extraction. As the assembly moves along the tubular member, the internal and external walls of the tubular member are blased, air cleaned, then profiles scanning, and the tubular member is ultrasonically checked. When sections 42 and 61 have passed the pipe end the reverse motion control is operated to reverse the direction of movement of the external processing unit and the probe. It should be explained that the supports are retracting into respective slots in the base sections, as are the clamps, to allow passage of the processing unit, the supports and the clamping being restored after passage of the assembly as controlled by the valves 25 and the cam 25A.

On the retraction stroke, the blasting, air cleaning, and both surface and sonic scanning sections are switched off automatically, the inhibitor spray sections 28 in the probe and 54 in the processing unit are switched on, as is the drying chamber 52. The assembly retracts along the tubular member coating the inner wall, and coating and drying the outer wall surface thereof with inhibitor. The tubular member is removed and replaced by another, the cycle repeating. Should a tubular member be found to have a defect, damage, or be out of tolerance, visual/audible warning is given to the operator in the cabin 10 who can override the auto cycle to manual control and re-check any suspect area or operation, or he can, alternatively,

fast retract the external processing unit and probe, have the suspect tubular member removed and replaced by other for another cycle. The operation cycle: blasting, cleaning, surface defect scanning and sonic scanning on the advance stroke, and inhibitor coating and drying on the reverse or retraction stroke are not obligatory in that the sequence can be changed and the activation on advance or retract strokes of any operation can be changed to suit requirements. The sequence illustrated is considered the most likely, but for example both visual surface and sonic scanning could take place on the retraction stroke.

It is considered that the equipment can accommodate all diameters of tubular member from 3 inches or smaller inner diameter, up to 36 inches inner diameter, using possibly three probe units. Lengths from 30 feet to 45 feet can be accommodated as standard; a change in base section assembly will accommodate shorter lengths if required, the centre base section being removed.

Referring particularly to Figures 9 and 10, control of the equipment is exercised from cabin 10 by means, inter alia, of hydraulic controller 67 and pneumatic controller 68, both of which are electrical/electronic units of conventional design. Electrical power for these controllers and the other electrical equipment is provided by the skid 21 via cable 22. The skid also provides a pressurised air supply to the equipment via an air hose 23. Hydraulic power is provided by a pump and tank unit 66 serving the hydraulic master setting valve unit 64, both of which are conveniently mounted on the bed 1A. The valves of unit 64 are

controlled from the controller 67 via control lines 69 and are operated so as to set the normal operating heights of the supports 6 and the clamps 7 by controlling the fluid supply in the hydraulic lines 71. Electrical feed-back signal is provided by the retrospective position sensors 65 during the setting up procedure along signal lines 70 to the controller 67 to enable the height of the supports and clamps to be set precisely. Once set, the valves of the master unit are not usually disturbed unless the size of tubing changes. The valves 25 enable operation of the hydraulic units so that the supports and/or clamps are retracted to their bottom-most positions during the traverse of the external processing unit 9.

A primary pneumatic supply is provided from the skid 21 to a manifold unit 72 contained on the external processing unit 9 via air hose 23. Manifold unit 72 supplies air to control valves in the control unit 73 which then distributes it under the control of the pneumatic controller 68 via pneumatic lines 74 to the various processing chambers 54, 55 and 56 of the external processing unit 9 and the processing sections 27, 28, 29 of the probe 8. Reservoirs 75, 76 containing supplies of shot or sand are incorporated in the pneumatic lines to the chamber 55 of the external processing unit 9, and the section 27 of the probe 8. These reservoirs are suitably mounted on the processing unit 9.

Cabin 10, in addition to the controllers 67 and 68 already referred to, will house various indicators, manual controls and also the controls for the inspection devices contained in the probe 8 and the external processing unit 9. In particular there is provided therein a visual display unit (VDU) 77 connected to video transmitters 39', 59' respectively situated in the probe 8 and the external processing unit 9 which are coupled to the aforesaid video cameras 39 and 59. The VDU displays simultaneously two traces 78, 79 representing the 360^{o} optical/video scans of the internal and external surfaces of the tubular member in a plane perpendicular to the axis thereof.

The probe 8 of this invention is particularly suitable for use, by itself, down-hole in an oil or gas well, or any other similar pipe lines which of course need not be vertical. A typical application is illustrated in Figure 11 which shows the vertical pipe 5' of a well.

Probe 8 is suspended on a standard wire line 13' which will incorporate an umbilical cable 13 (not shown). The wire line is payed out from a drum 12' which stores the unused wire line and provides a termination for the umbilical cable. The video signal is coupled via the umbilical cable to a VDU 77' which is illustrated showing a trace corresponding to a scan of the internal wall of the pipe 5'. The apparatus is preferably entirely portable, so that it may be set up in the field wherever required, and may include its own power supplies and other services. The facilities of the probe may be limited to air and/or abrasive particle blasting and the optical/video scanning equipment but may also include

the inhibitor spraying and air drying facilities.

In a typical operation, the probe may be lowered to a position where damage is suspected or alternatively the length of the pipe may be inspected from the surface downwards until a faulty or damaged section is located, the inspected section of the pipe is cleaned and is then scanned with the optical/video equipment. If a pipe section needs to be replaced, then the pipe string would be withdrawn from the well to the surface, the probe unit would be reassembled into the main assembly shown in Fig. 1, a new pipe section would be checked and treated, the faulty section would be removed from the pipe string, the new section would be inserted therein in place of the faulty one, and the string would be returned down-hole.

Although particular embodiments of the invention have been described and illustrated herein, modifications and variations may readily occur to those skilled in the art. Thus the pipe lines referred to generally herein are not limited to the pipes or pipe sections of oil and gas installations but may also include thermal and water installations, pipe lines in chemical plants and supply lines for other plants and installations. Consequently it is intended that the claims herein be interpreted to cover such modifications, variations and applications.

CLAIMS

1. In a method of treating elongate tubular members such as the production pipe sections used for oil or gas wells the improvement comprising the progressive zonal treatment along the length of at least one surface of the tubular member such that the entire treatment is carried out in one cycle of operation, said cycle including a forward and a return pass along the member and said treatment comprising cleaning the member and at least one of the following further treatments: inspection, coating with a corrosion preventative material and forced-air drying.

2. A method according to Claim 1 wherein said treatment is carried out simultaneously on the internal and external wall surfaces of the member within the same zone.

3. A method according to Claim 1 wherein the step of cleaning the pipe comprises blasting with abrasive particles followed by the removal of dust and loose particles by means of forced-air jets.

4. A method according to Claim 1 wherein the step of forced-air drying includes the step of heating the air before it impinges on the tubular member.

5. A method according to Claim 1 wherein the step of inspecting the tubular member includes at least one of the following processes: circumferential video profile inspection, circumferential video profile measurement, circumferential ultrasonic scanning, circumference atomic radiation emission scanning.

6. Apparatus for treating elongate tubular members such as the production pipe sections used for oil or gas wells according to the

method of Claim 1, said apparatus comprising a bed for supporting the member along its length and means comprising cleaning means and at least one other means from a group comprising inspection protective coating and forced-air drying means, which means is arranged so as to pass along the length of the member and back again whilst continuously treating the latter over 360^{o} of at least one of its surfaces.

7. Apparatus according to Claim 6 including a probe member for passage along the inside of the tubular member and an external processing member having a tunnel for receiving the tubular member and the probe member, said external processing member being supported on said bed and being movable along it, being guided thereby, and said probe member and said external processing member being maintained in fixed spatial relationship, each thereof containing means for cleaning the respective surfaces of the tubular member, and at least one other means from the group comprising means for inspecting the said respective surface, means for applying a protective coating to said respective surface and means for forced-air drying, said members being connected to service means and supply means through respective couplings.

8. Apparatus according to Claim 7 wherein said probe has a plurality of extendable arms at each end for supporting it centrally within tubular members of various internal diameters and an expandable and retractable telescopic support at one end for supporting the probe in a fixed spatial relationship with the external processing member, and wherein the probe is connected to

its respective service and supply means through an umbilical cable which passes through said telescopic support.

9. Apparatus for treating elongate tubular members such as the production pipe sections used for oil or gas wells comprising an elongate bed, an external processing member for processing the external surface of the tubular member and a probe member for providing internal surface processing of the tubular member, said external processing member having a processing tunnel for receiving a tubular member, being supported on said bed and having driving means for driving the said processing member forwards and backwards along the bed, and said member providing in circumferential zones along the tunnel hot air means for supply drying air under pressure, inhibitor application means for spraying a corrosion prevention coating on the tubular member, abrasive particle blasting means, air cleaning means for removing dust and abrasive particles from the external surface of the tubular member, optical video scanning means for profile scanning of the said external surface and providing remote visual inspection thereof, and, in a final zone, ultrasonic receptor means, said zones providing 360^{o} processing testing and inspection around the tubular member, and said processing zones being separated from one another and from said testing and inspection zones by means of sealing members comprising perforated flexible diaphragms, wherein said probe member is supported centrally within the tubular member by means of retractable arms at each end and is supported at one end from the bed by means of a telescopic slidable support means including

drive means for expanding and retracting the telescopic slidable support so that the probe maintains a fixed spatial relationship with the said external processing member, said probe member defining treatment zones along the length comprising in succession abrasive particle blasting means, inhibitor applicator means for spraying a corrosion prevention coating on the tubular member, compressed air cleaning means, optical/video scanning means for profile scanning of said internal surface and providing remote visual inspection thereof and, in a final zone, ultrasonic transmitting means, said probe member being located relative to the external processing member such that the optical/video scanning means and the ultrasonic means of each member are maintained in registration and said treatment zone providing 360^{o} processing, testing and inspection of the interior surface of the tubular member, said probe member being connected to remote services and supplies by means of an umbilical cable passing through said telescopic slidable support, and wherein said tubular member is supported by means of a plurality of retractable supports which are selectively retracted into the bed to permit the passage of the external processing member along the bed whilst a tubular member is in position on the bed.

10. Apparatus according to Claim 9 wherein said bed is formed of a plurality of sections which may be added to or reduced in number so as to accommodate tubular members of varying lengths.

11. Apparatus for the remote treatment and inspection of the interior wall of a pipe line comprising a probe for insertion into the pipe line, said probe having centralising arms for maintaining it in a centralised attitude within the pipe line, pipe cleaning means, at least one other means from a group comprising inspection, protection coating and forced-air drying means, and an umbilical connection to supply control and indicating means provided at the end of the pipe, said umbilical connection providing services and control signals to the probe and transmitting inspection signals to said indicating means.

12. Apparatus according to Claim 11 wherein said cleaning means comprises means for blasting the internal wall of the pipe with abrasive particles and means for removing loose surface contaminants such as dust, rust, etc. from said pipe before or after blasting and said inspection means comprises optical/video profile scanning means for providing progressive three-dimensional line scans of the internal pipe surface, said cleaning means and said inspection means treating and inspecting the full 360^{o} of the said surface.

13. Apparatus according to Claim 12 wherein said supply, control and inspection means includes a drum for storing those sections of the umbilical connection not payed out into the pipe line and further includes a visual display unit for displaying the scanning signals obtained from the optical/video profile scanning means.

0173870

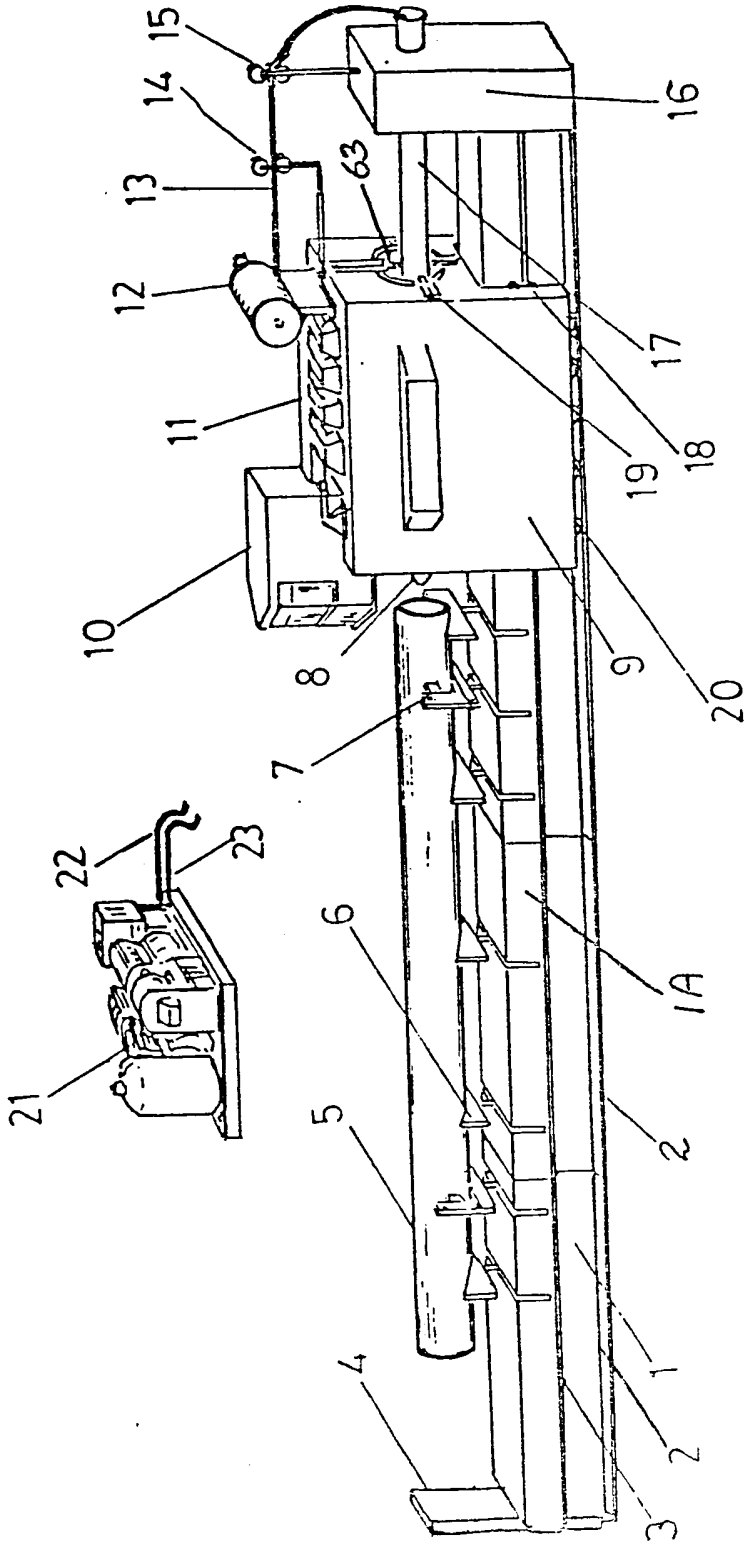


FIG. 1.

0178870

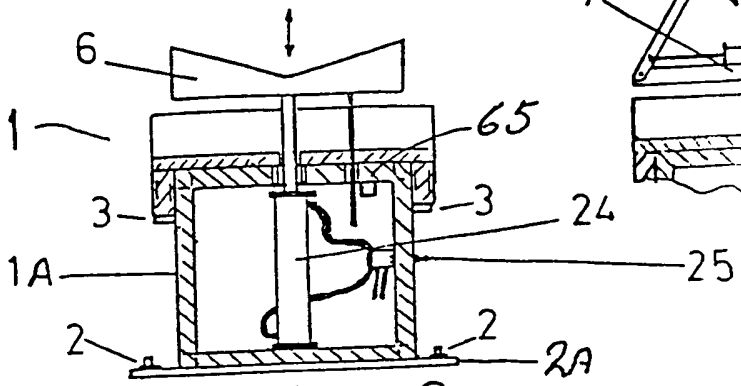


FIG. 2

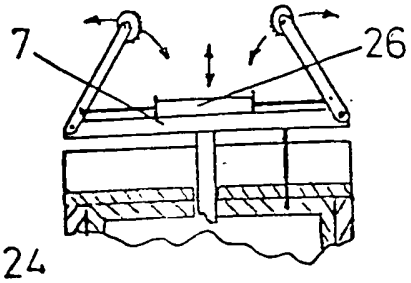


FIG. 2A

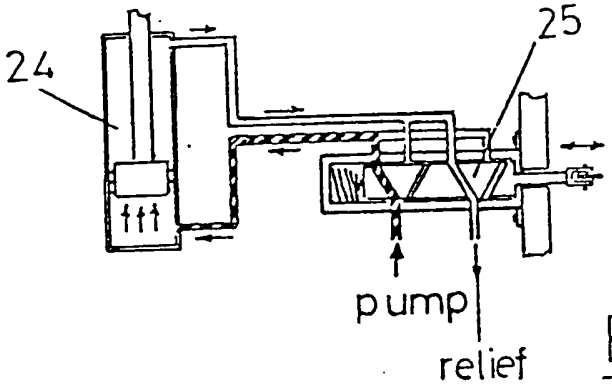


FIG. 3.

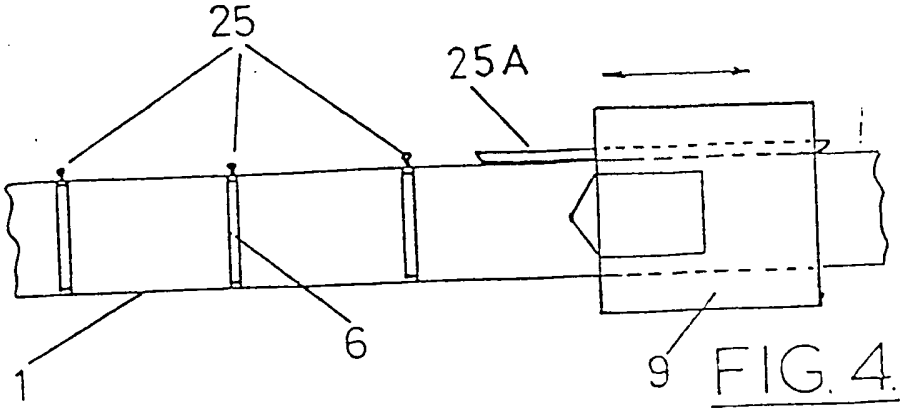


FIG. 4.

0178870

FIG. 5.

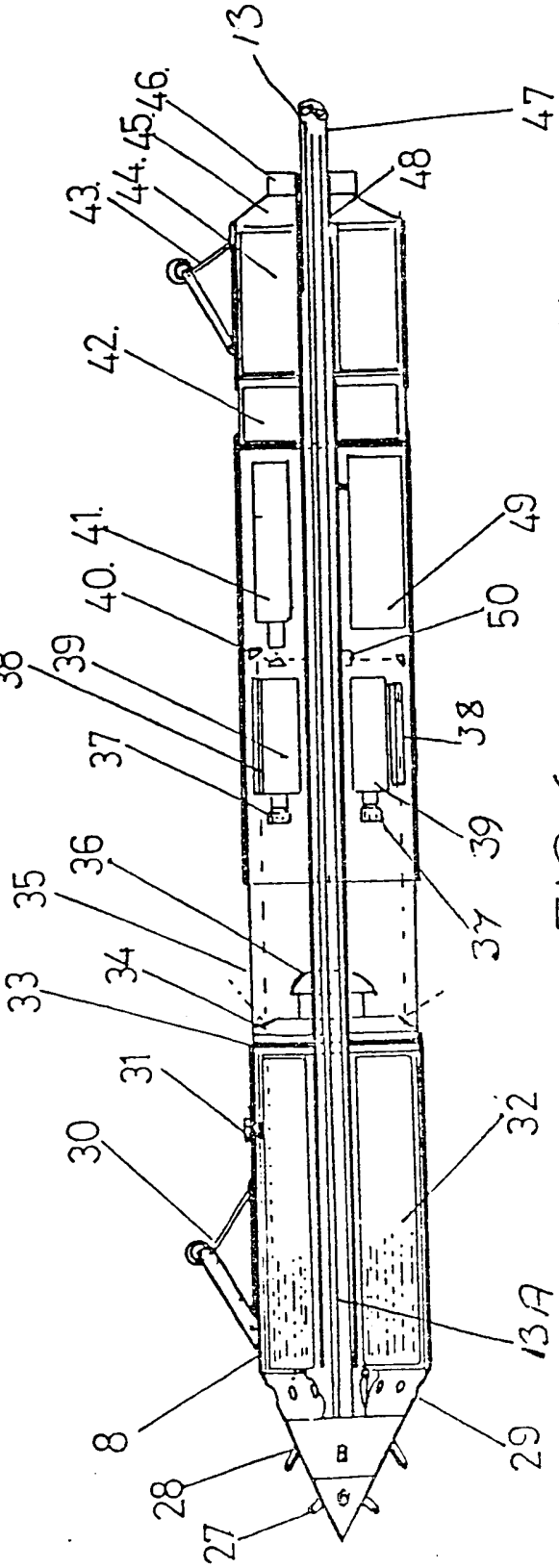
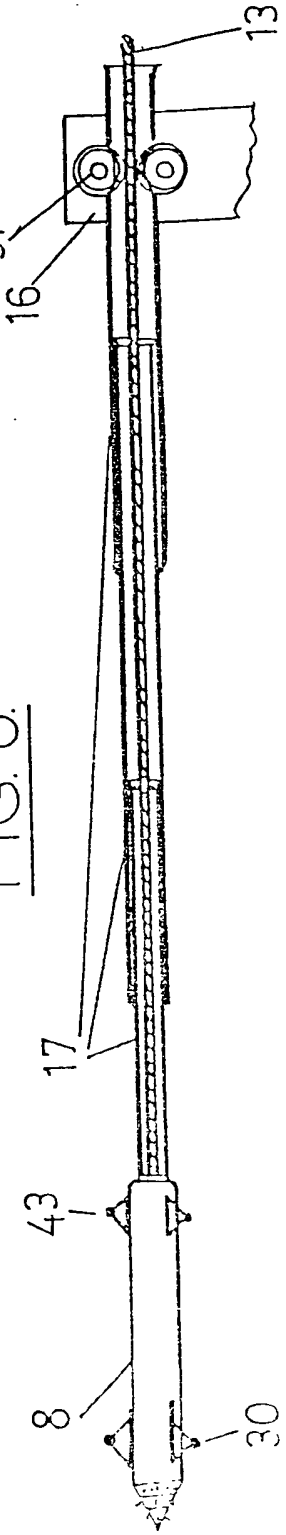


FIG. 6.



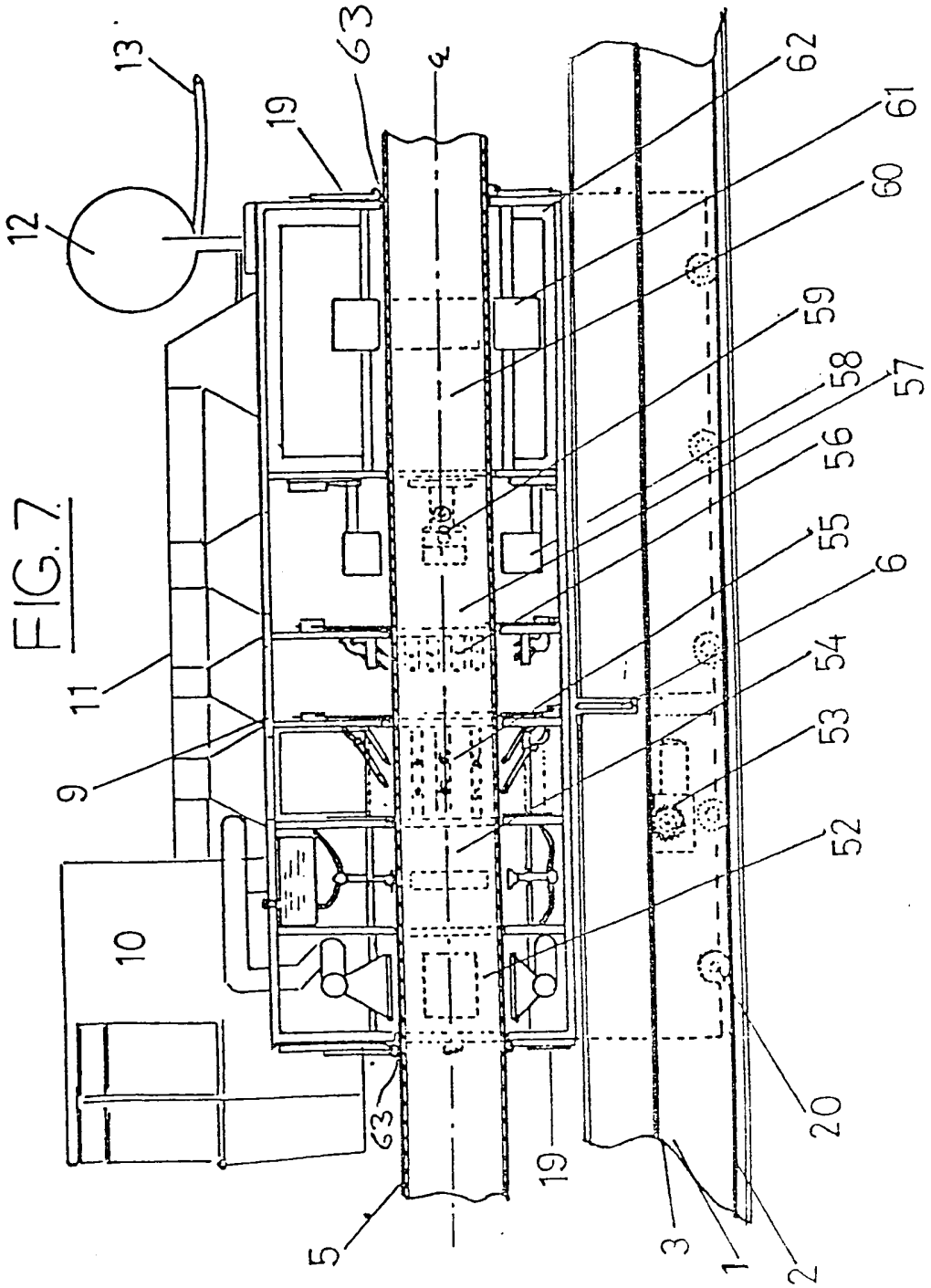
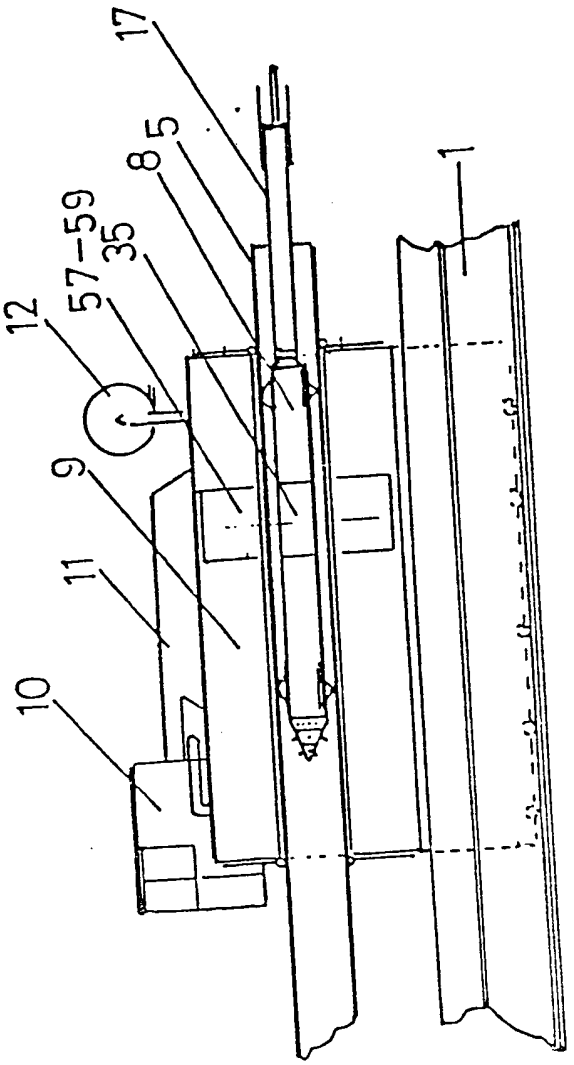


FIG. 7

0178870

FIG. 8.



0178870

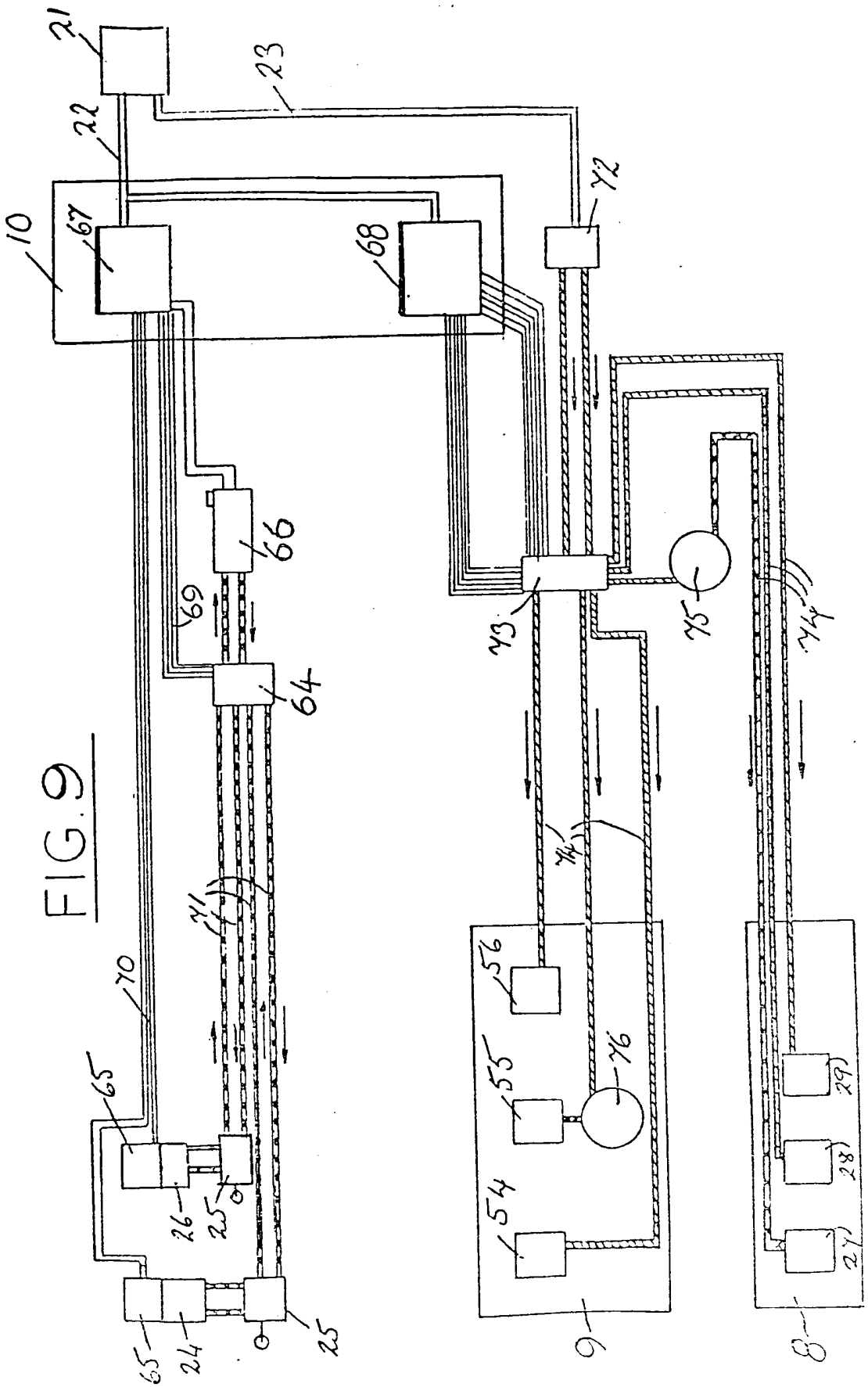


FIG. 9

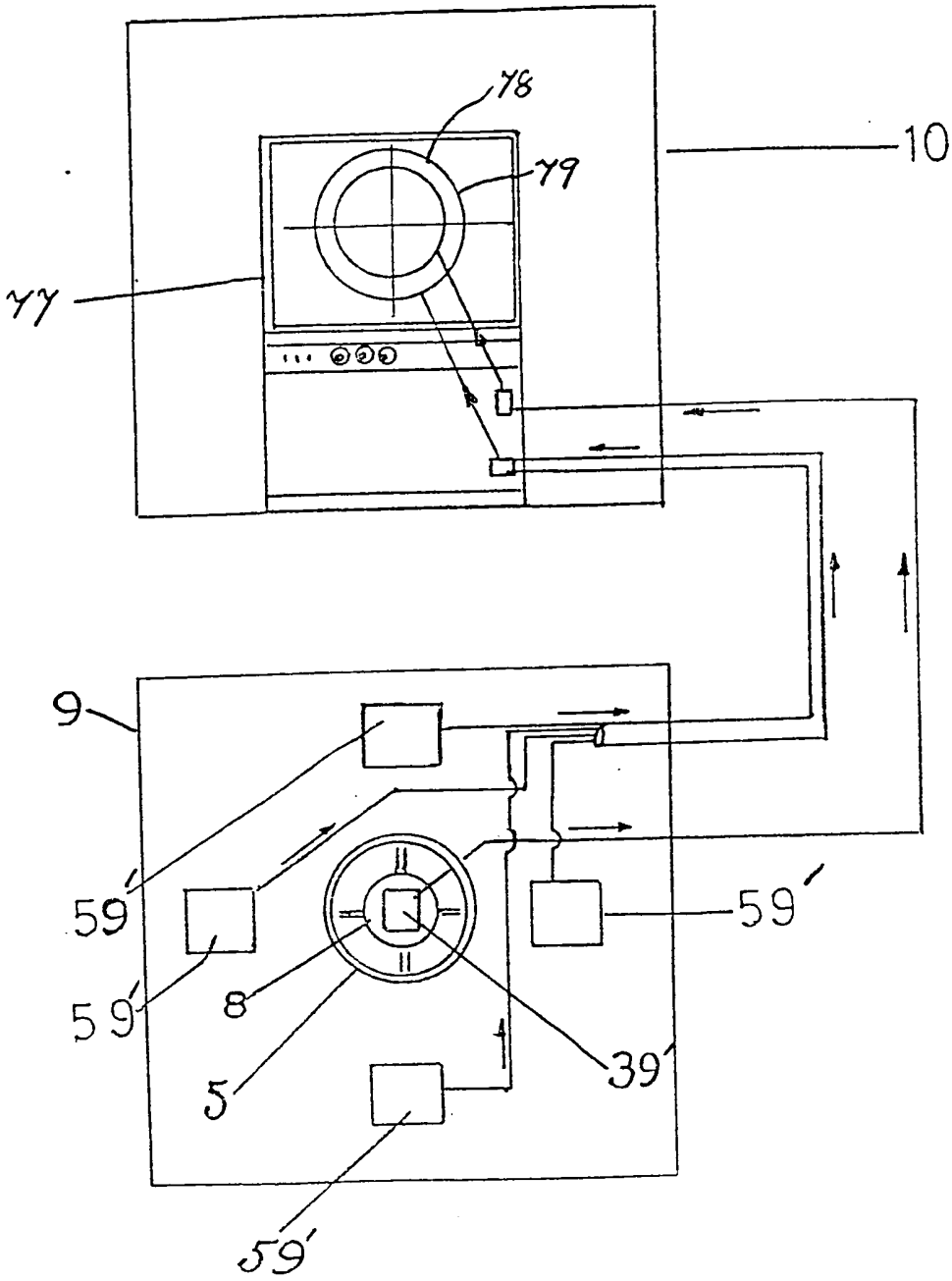


FIG. 10

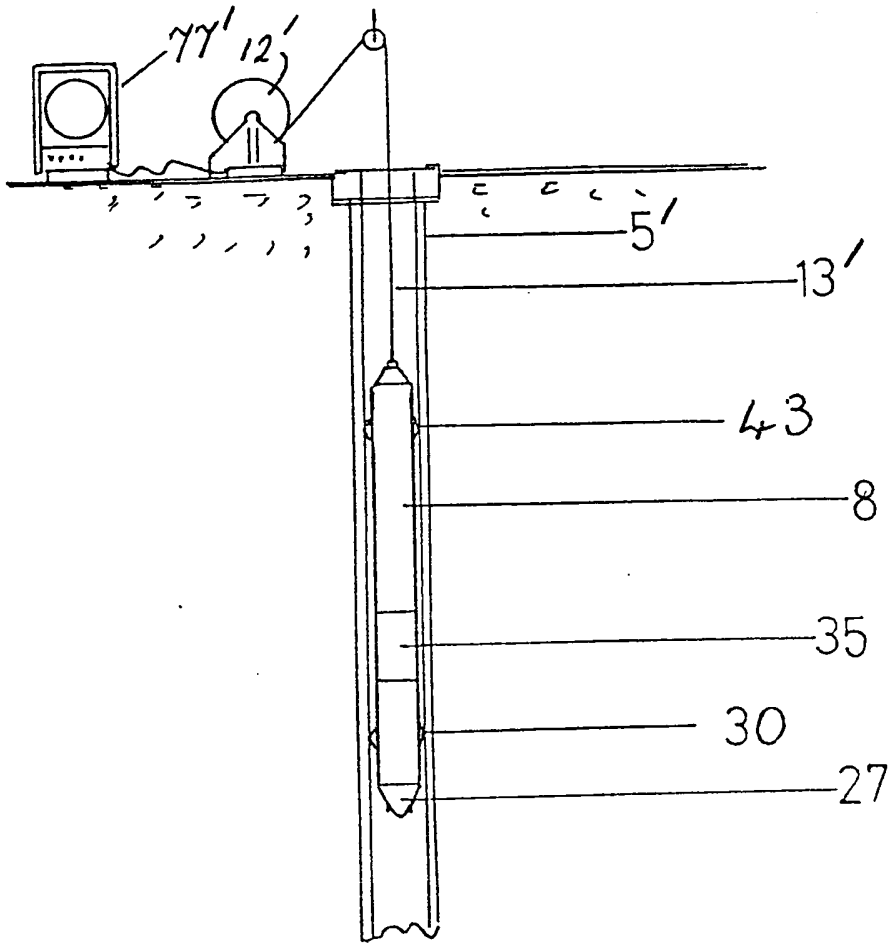


FIG. 11.